MTM

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In This Issue . . .

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MTM

The Journal of Methods-Time Measurement

May-June 1958

MTM ASSOCIATION FOR STANDARDS AND RESEARCH

The Journal of Methods-Time Measurement is dedicated to the technical aspects, application developments and general news items concerning the advancement of MTM.

The Journal encompasses the fields of endeavor that were formerly publicized in the MTM Newsletter and MTM Bulletin.

The technical section of the Journal is concerned chiefly with recent research developments both from the established research program at the University of Michigan, Ann Arbor, Michigan, and from somewhat smaller allied projects being conducted throughout the Association membership.

New applications of MTM as well as refinements of established applications are presented in the Application Section to illustrate specific approaches to management problems that can be solved through the use of Methods-Time Measurement.

Current events in the lives of persons associated with MTM are described in the general news section.

The Editorial Staff welcomes contributions for all three sections described.

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May-June 1958

MTM Association

Editor.......................... Richard F. Stoll

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TECHNICAL I

INSTRUMENTATION USED IN A LABORATORY STUDY OF APPLY PRESSURE

by

Barbara Ettinger Goodman, Research Assistant
and
James Foulke, Student Assistant
Engineering Research Institute - University of Michigan

The problem of investigating "Apply Pressure" centers around the determination of its nature, of the variables which do and do not affect it, and of the time necessary to perform this element. As a starting point for this experiment, the definition of Maynard, Stegmerten, and Schwab from their book, Methods - Time - Measurement was used. This definition states that Apply Pressure is a momentary hesitation during which force is applied to overcome the effects of resistance which are too great to be overcome by a normal motion. In order to learn more regarding this matter, it is necessary to conduct both a laboratory and an industrial study from which data is gathered, analyzed, and studied. The purpose of this paper is to discuss the instrumentation of the laboratory phase of this experiment into the nature of Apply Pressure.

Before any definite instrumentation could be utilized, it was necessary to determine the form in which the data would be most desirable. It was decided that both qualitative and quantitative information would be needed in order to give a true picture of an Apply Pressure. We felt that the qualitative information should be a picture of the instantaneous force exerted by the subject and the quantitative data should tell us the starting and ending points of this same application of pressure. Therefore the form we thought best for the data to take was one of the main factors influencing the design of the equipment used in the laboratory study. Another major consideration was that of validity. Our apparatus would have to enable us to measure the pertinent parts of applied pressure to the desired accuracy. Furthermore, it was thought important that we should be able to make the necessary changes from one situation to another easily and quickly so that flexibility was one more goal to be considered. Because we wished the subjects to apply a wide range of forces during the course of the laboratory experiment, the apparatus needs be sensitive and sturdy enough to withstand any pressure which the subject might exert. Sturdiness and sensitivity therefore became further objectives in design. One more quality wanted from the apparatus was reliability. This was perhaps a most selfish consideration since the thought of frayed and frazzled nerves from tempermental equipment was not appealing. Finally, because our budget was not unlimited, we strove consciously and unconsciously to be as economical as we could without jeopordizing our results. In summary, the form of the data and the qualities of validity, flexibility, sturdiness, sensitivity, reliability, and economy were the factors taken into consideration in the design of the equipment.

The experimental situation can be seen in Figure 1.

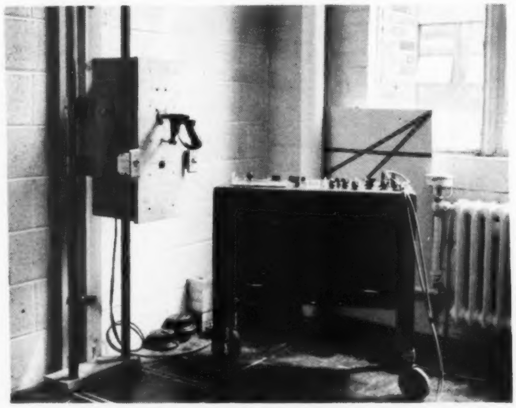

Fig. 1

To the left is the apparatus on which the applied pressure is performed and in the center is the Sanborn recorder on which the information obtained from the apparatus to the left is recorded on two channel Sanborn recording Permapaper. The graphs are recorded on this special paper through the action of a heated stylus which melts a chemical on the surface of the paper. This setup gives us a permanent record which is not subject to the messiness and erasibility of a pen and ink record. The applied pressure apparatus is clamped on two parallel bars which are two inches in diameter and six feet long and allow for adjustment to various heights. The switches on either side of the front panel are used during the experimental operation described below. The apparatus is pictured with one of the levers

mounted. This particular handle is supported on a shaft which permits it to move foreward or backward, i. e., it may be pushed or pulled by the subject. The force applied is transmitted via a bar in the center of the panel to a measuring mechanism. In addition to the lever pictured, the panel serves as a mounting for a push button, a squeezable lever, a horizontal bar lever, and a palm lever, all of which are variables in the experiment.

At the start of an operation, the left switch is in an up position and the right switch is down. The subject performs the continuous cycle of grasping (flicking is outlawed) one switch, moving it down if it's up or vice versa, pushing the lever, then grasping the other switch and moving it up when it is down or vice versa. After the subject has become familiar with an operation and is working with a smooth steady rhythm, we turn on the Sanborn recorder and start gathering data.

Perhaps you are asking yourself why the switches were included as a part of the procedure and why we are so particular about the way the subject handles them? The purpose of the switches is threefold. First of all, since an Apply Pressure generally appears as one element in a whole group of motions, we wanted this same situation present in our study. Secondly, we wanted to divert some of the subject's attention away from the lever and so the switches were added to take the spotlight periodically from it. Thirdley, because we wanted to record a series of at least ten cycles at one time, we needed some assurance that the subject would begin each cycle with about the same level of muscular tension in his arm. We wanted to eliminate residual muscular tension from the previous application of pressure. If the subject were just pushing (or pulling) the lever without performing fine motions afterward, there would be no stimulus for him to release most of the tension previously built up. By requiring the subject to grasp a switch and move it up (or down) we are in essence requiring a release of most of the stored tension; and this release was not obtained by flicking the switch which is a gross motion.

The following MTM Analysis is presented only to give you an idea of one of the motion patterns which our subjects use in the course of the experiment. However, as we change the levers mounted on the apparatus, the weights suspended on the bell crank situated behind the panel, the position of the subject in relation to the lever, and the amount and kind of lever travel, the motion pattern also changes to some extent. Furthermore, it should be remembered that the MTM analysis was made independent of any laboratory findings. More important, what is being done in the laboratory is not influenced by this analysis. This last comment particularly applies to Element 3.

The lever mounted on the apparatus during this analysis is the one pictured in Figure 1. Also, there was no weight suspended on the bell crank at that time. The subject stood facing the panel with her right arm in line with the lever. Moreover, the angle between her upper arm and forearm was about 90 degrees.

With the analysis (see following page) we are now in a position to discuss the instrumentation which made this analysis possible.

The term, "Apply Pressure," implies the relationship of force versus time. In order to measure this relationship, it is convenient to record force as a function of time on a resistance strain gage recorder. These instruments detect strain in terms of a small resistance change in a resistive element which is applied to the specimen under test. This resistance change is then compared electrically (in a bridge circuit similar to that of the Wheatstone bridge) to a known resistor which allows the change to become a direct measure of the force applied to the specimen.

In solving the problem of recording force as a function of time, it became necessary to develop a mechanical system whereby force could be conveniently measured with resistive strain gages. The bell crank shown in Figure 2 proved to be a satisfactory solution to the problem.

In the apparatus as pictured the bell crank is fastened to a panel on which the lever under test is mounted. A short bar passing through the panel transmits to the bell crank the force applied to the lever under test. The strain thus produced is recorded as a force on the recorder.

The weight suspended on the freely pivoting bell crank provides the desired resistance to the force associated with Apply Pressure. Using this arrangement we are able to alter resistive forces easily. After the required pressure has been developed the system will commence to move. The stops (A & B) limit the distance the lever moves to the controllable increments demanded by the experiment.

In analyzing Apply Pressure (Fig. 3 top) it was found that in order to precisely locate the beginning and end of the cycle, it would be desirable

MTM ELEMENT ANALYSIS

File

Part Name ______ Part No. ______
Oper. Name A-6-0-D-AL, Oper. No. ______
Operator BARBARA GOODMAN No. ______ Analyst NURAMATSU Date 2-24-58

DESCRIPTION - LEFT HAND	F	MOTION	THU	MOTION	F	DESCRIPTION - RIGHT HAND
1. Push Left Switch						
		R1A	2.0			
		G1A	2.0			
		M1A	2.5			
		RL1	2.0			
			8.5			
2 Reach to Handle		R13A	10.1			
3 Push Handle						
		R2A	4.0			
		45	0.0			
		R4A	6.1			
		G2	5.6			
		AP2	10.6			
		R4A	6.1			
			32.4			
4 Reach to Right Switch		R9B	10.8			
5 Push Right Switch same 1			8.5			
6 Reach to Handle		R9A	8.3			
7 Push Handle same 3			32.4			
8 Reach to Left Switch		R13B	13.7			
Total			130.7			

Sheet ______ Of ______

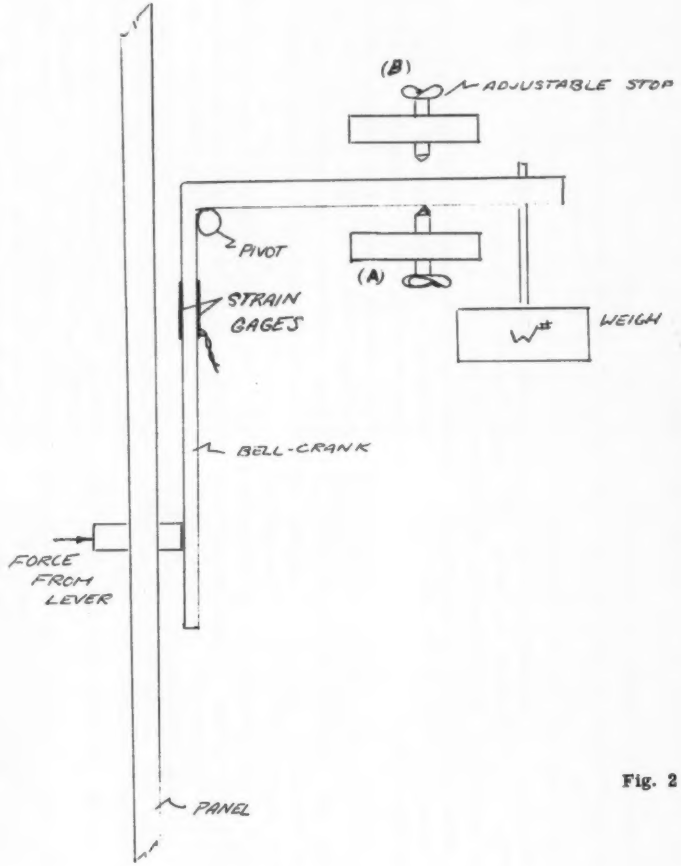

Fig. 2

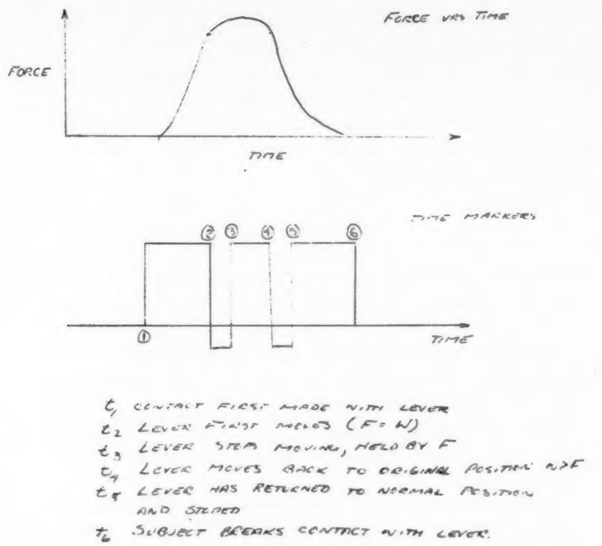

Fig. 3

to know when the subject first established complete contact with the lever under study. If you have ever worked with a sensitive bridge circuit, you know that if you make contact with a part of the ungrounded circuit, a measurable unbalance can be detected. Use of this circuit behavior is made by insulating the lever under test from the apparatus and connecting it then to a sensitive bridge circuit similar to that used to measure the resistance change due to strain (the force applied to the lever). This gives us an accurate timing mark for the beginning and ending of the cycle.

In order to add more information to the timing curve (Fig. 3 bottom) it was decided that the moments the bell crank started and finished moving should be determined. This information was found by grounding the bell crank and insulating the adjustable stops. The stops could then be used as switches. By connecting the stops in parallel and then wiring them in series with a resistor connected in the bridge which determines contact with the lever, we get the information shown in Figure 3 bottom. This information allowed a detailed analysis of Apply Pressure to be made.

The relationship between the grounded bell crank and the insulated stops during all parts of the Apply Pressure cycle can be shown diagrammatically. All the while the subject is building up tension in his arm, from t_1 to t_2 in Fig. 3, the bell crank is resting on Stop A. (Fig. 4)

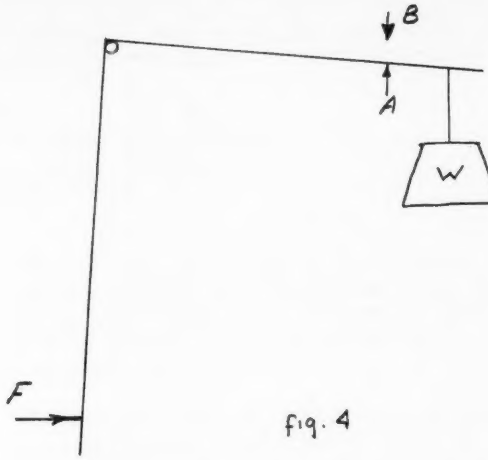

Fig. 4

When sufficient force has been applied to the bell crank to overcome the resistance of it, both the lever to which the force is being applied and the bell crank begin to move. This move ends when the bell crank reaches Stop B, i.e., in the time interval from t_2 to t_3 in Fig. 3, the bell crank is moving from Stop A to Stop B. (Fig. 5)

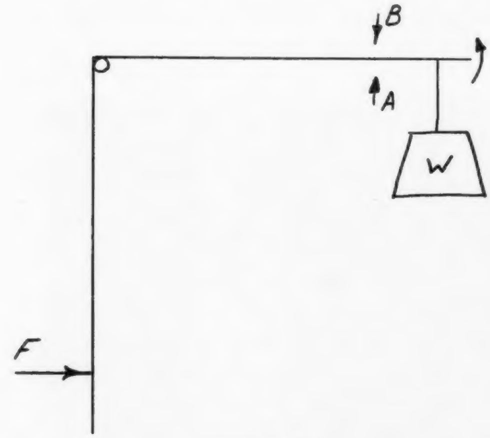

Fig. 5

For physiological reasons the subject holds the lever against the panel a certain length of time, from t_3 to t_4 in Fig. 3. During this interval the bell crank is held against Stop B (Fig. 6)

When the force in the subject's arm has been reduced to a level which is less than the resistance holding the lever, then the lever and the bell crank move back to their initial positions.

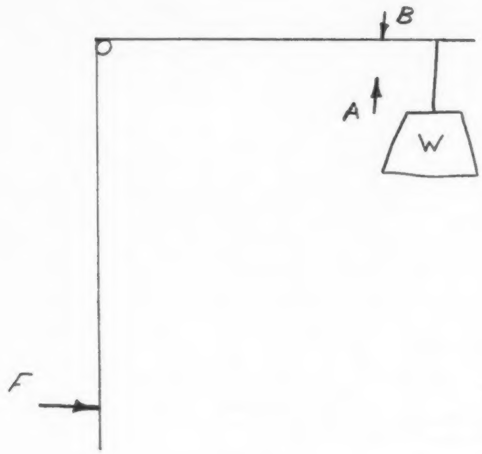

Fig. 6

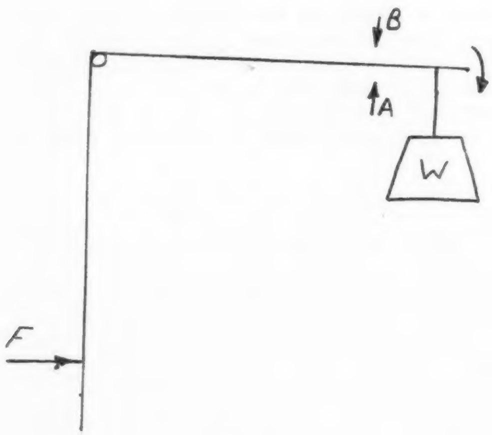

Fig. 7

In this interval, from t_4 to t_5 in Fig. 3, the bell crank is moving from Stop B to Stop A. (Fig. 7)

After the lever and the bell crank have returned to their initial positions, it takes additional time, from t_5 to t_6 in Fig. 3, is required by the subject to remove his hand from the lever. During this period the bell crank rests against Stop A. (Fig. 8)

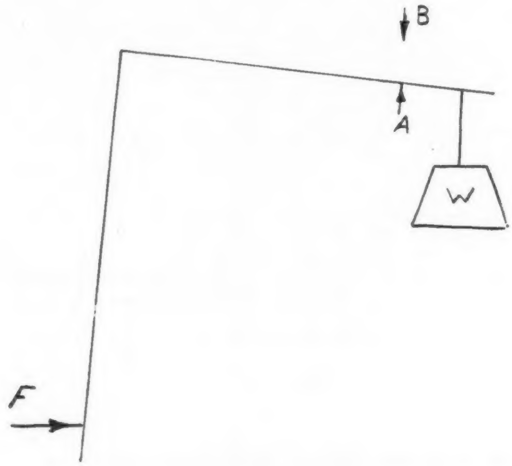

Fig. 8

With the electronic equipment described here, we have been able to disect an element about which little is known. One of the tasks remaining is to analyze and digest the data we have gathered in an attempt to answer the question what affects the time it takes to do an Apply Pressure?

APPLICATION I

GUIDE FOR SAFE LOCATION OF TWO-HAND TRIP BUTTONS ON POSITIVE TYPE CLUTCH PUNCH PRESSES

by

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Hamilton, Ontario, Canada

Over the past number of years industry has become increasingly aware of the expense created by accidents, not only the cost of compensation and hospitalization, but also of lost production, employees unrest, and in some cases permanent disabilities. It was this awareness that started safety programs, and in many industries today full time safety staffs are employed.

In Canadian Westinghouse the safety program has reduced the accident rate per million man hours, from 11.7 in 1952 to 9.3 in 1957. A reduction of 20% in the last 5 years.

It has been through the efforts of similar safety staffs, in addition to accident prevention and safety organizations, that the industrial accident rate has been reduced and is still on the downward trend today.

Punch presses for many years, have been among the worst offenders in the number of accidents causing injury to, or loss of, arms, hands, and particularly fingers. This high accident rate has led to the development of such safety features as; sweep, pull-out, and electronic guards, as well as two-hand tripping devices.

The two-hand trip was found to be hazardous, in that, an operator could injure himself by reaching into the press while the ram was on the down stroke. It was noted that presses equipped with friction clutches required constant pressure on the trips during the downstroke, otherwise the machine would stop automatically. This, therefore, would not be a safety hazard. However, presses equipped with positive type mechanical clutches could be injurious, as this press will complete the stroke once the cycle has started, even if trips are released.

Our department was thus presented with the problem of determining a safe distance at which to locate the two-hand trips on mechanical-clutch presses. Fig. 1 and Fig. 2 show two common types of machine mounted two-hand trips.

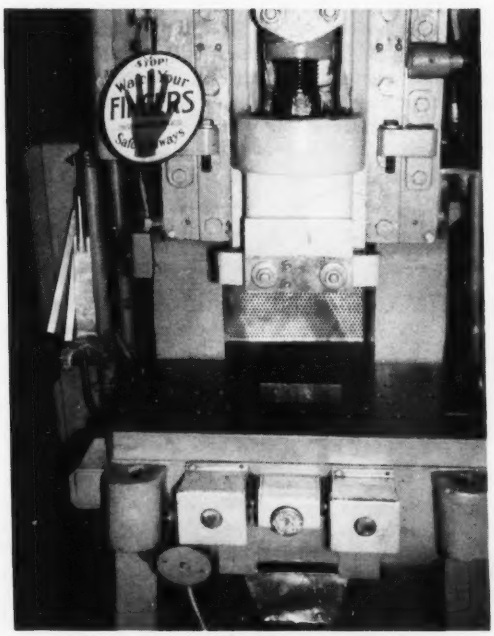


Fig. 1

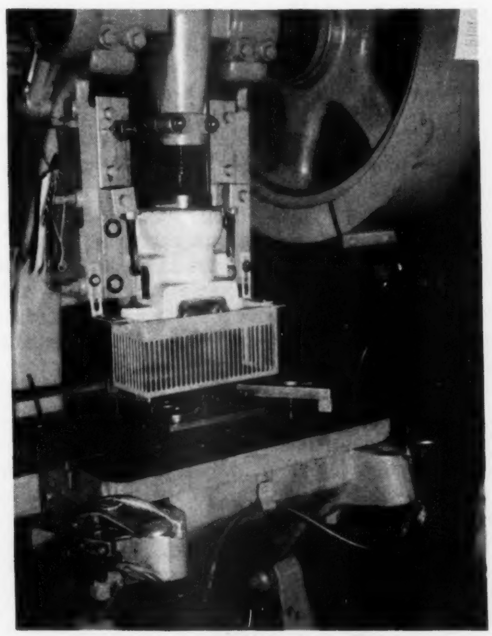


Fig. 2

The first variables noted were, stroke speed (or strokes per minute) and stroke length. Delving deeper, it was found that some machines had an instantaneous trip while others experienced a time delay waiting for the clutch position to revolve for engagement, called "clutch lag." Further investigation highlighted the point that when the punch was 1/4 inch above the die no damage could be done to a body member. All these factors could be calculated, and the results produced in time. As the end result required was a safe recommended distance, at which to locate the trip buttons, it was necessary to find a way to change time into distance. For this purpose, it was essential to use a predetermined time system and Methods Time Measurement was chosen, as it is internationally used, and is one of the time measurement techniques in use at Canadian Westinghouse.

MTM, which is an abbreviation for Methods Time Measurement, is a procedure that analyses a manual operation or method into the basic motion required to perform it, and assigns to each motion a predetermined time standard, which is determined by the nature of the motion and the conditions under which it is made. It is based on the following facts:

1. Any manual operation is made up of distinct and recognizable basic motions.
2. Each basic motion has a constant time value at the average performance level.
3. Research has measured the time values for all basic motions. These time values are published on what is known as the MTM data card.

As indicated, the MTM data are measured time values for all basic motions. A variety of operations were photographed. At the same time, all the conditions surrounding the operation were recorded. Each operator was rated by an accepted leveling procedure. Detailed analysis of the resulting films yielded time values for each basic motion. These have been substantiated by frequent checks against time study data and also through research by Cornell University.

The unit of time as shown on the MTM data card is a Time Measurement Unit, abbreviated to TMU. The data card or tables therefore, show the number of TMU's required by an operator of average skill, working with average effort, to make the motions under average conditions.

To change TMU into time units, the following conversion factors must be applied:

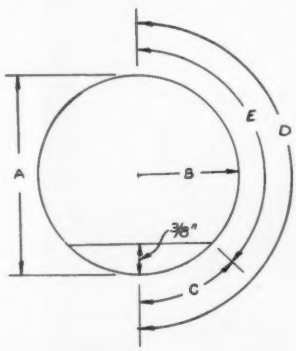
1	TMU	=	.00001	Hours
1	TMU	=	.0006	Minutes
1	TMU	=	.036	Seconds

The foregoing has provided some history and familiarization with the factors involved. The remainder of this article will deal with the steps taken, and mathematics used, to compile the final application sheet. Wherever an explanation is required, it will be noted prior to the computations so that the method of compilation will be explained in its correct sequence.

STEP #1 - Time required per stroke, at various stroke lengths, and Machine Speeds

The first basic step was to determine the amount of time contained in the down stroke of the press that an operator could injure his hands. Recognition of the fact that on the average, the punch entered the die by 1/8 inch, and that it would be impossible for an operator to get his fingers into the die in the 1/4 inch of stroke prior to the punch entering the die, resulted in the equation: Down stroke - 3/8" = Portion of stroke that could be considered dangerous.

The next problem in this basic step was to determine the percentage of down stroke when injury could be caused. This is complicated by the action of the press, as the ram is actuated by an eccentric driver. The problem then became the percentage of the arc required to move the ram all but 3/8 inches. The following diagram will serve to clarify the problem. The circle represents the travel of the eccentric in one complete stroke.



LEGEND

A. Stroke length
B. Eccentric radius
C. Arc of down stroke considered safe
D. Down stroke
E. Arc of down stroke possible dangerous

All that is left at this point is to complete the calculations necessary for the various strokes of the presses in our press department. This was compiled in table form for ease of calculation and reference.

A Stroke length in inches	B Eccentric Radius in inches	C Arc of safe stroke	D Arc of down stroke (B x 3.142)	E Danger portion (D-C)	F Percent of Stroke (E x 100 / D)
2	1.0	.90	3.14	2.24	71.3
3	1.5	1.09	4.72	3.63	76.9
4	2.0	1.24	6.23	4.99	80.1
5	2.5	1.39	7.86	6.47	82.3
6	3.0	1.52	9.42	7.90	83.9
7	3.5	1.63	10.98	9.35	85.2
8	4.0	1.76	12.57	10.81	86.0
9	4.5	1.85	14.12	12.27	86.9
10	5.0	1.95	15.70	13.75	87.6
11	5.5	2.04	17.28	15.24	88.2
12	6.0	2.13	18.85	16.72	88.7
13	6.5	2.21	20.45	18.24	89.2
14	7.0	2.31	22.00	19.69	89.5
15	7.5	2.40	23.55	21.15	89.8

Having determined the percent of stroke considered to have the possibility of injury, it is necessary to apply this to the time required for the machine to complete the down stroke. This is done by calculating the time per stroke in decimal hours and dividing by two (2).

As all time calculations will eventually be converted to distance through the use of MTM, they have been calculated in TMU's (time measurement units).

Strokes/Min	Dec. hrs/stroke	Down stroke in T.M.U's
50	.000333	16.7
60	.000278	13.9
70	.000238	11.9
80	.000208	10.4
90	.000185	9.3
100	.000167	8.4
110	.000153	7.7
120	.000139	7.0
130	.000128	6.4
140	.000119	6.0
150	.000111	5.6

To complete the first basic step, it is now necessary to multiply the percentage found in the first calculation by the time from the second. As the per cent varies with stroke length, and the time varies with the strokes per minute, it was required to construct Table A.

TABLE A

TIME IN T.M.U. THAT STROKE COULD CAUSE INJURY

Stroke length	NUMBER OF STROKES PER MINUTE										
	50	60	70	80	90	100	110	120	130	140	150
2	11.9	9.9	8.5	7.4	6.6	6.0	5.5	5.0	4.5	4.3	4.0
3	12.9	10.7	9.2	8.0	7.2	6.5	5.9	5.4	4.9	4.6	4.3
4	13.4	11.1	9.5	8.3	7.4	6.7	6.2	5.6	5.1	4.8	4.5
5	13.7	11.4	9.8	8.5	7.6	6.9	6.3	5.7	5.2	4.9	4.6
6	14.0	11.7	10.0	8.7	7.8	7.1	6.5	5.8	5.4	5.0	4.7
7	14.2	11.8	10.1	8.8	7.9	7.2	6.6	6.0	5.4	5.1	4.8
8	14.4	12.0	10.2	8.9	8.0	7.2	6.6	6.0	5.5	5.2	4.8
9	14.5	12.1	10.4	9.0	8.1	7.3	6.7	6.1	5.6	5.2	4.9
10	14.6	12.2	10.5	9.1	8.2	7.4	6.8	6.1	5.6	5.3	4.9
11	14.7	12.3	10.5	9.2	8.2	7.4	6.8	6.2	5.6	5.3	4.9
12	14.8	12.3	10.6	9.2	8.3	7.5	6.8	6.2	5.7	5.3	5.0
13	14.9	12.4	10.6	9.3	8.3	7.5	6.9	6.3	5.7	5.4	5.0
14	15.0	12.4	10.7	9.3	8.3	7.5	6.9	6.3	5.7	5.4	5.0
15	15.0	12.5	10.7	9.3	8.4	7.6	6.9	6.3	5.8	5.4	5.0

STEP #2 - Time Consumed by Clutch Lag on Various Clutches and Machine Speeds

The second basic step was to determine the affect of the delay created when the clutch does not engage instantaneously, which for our purpose has been termed "clutch lag." It was found that four conditions could exist:

1. Instantaneous — Where the clutch engages instantly. As there is no time lag in this condition, allowances for it will not be required.

2. 2 Position Clutch — Clutch engages in any one of two positions. This means that the flywheel could revolve 180° before engaging. The revolution of 180° is the maximum or worst possible condition and therefore is used as the basis for calculation. The same criterion is used in the remaining clutch conditions.

3. 3 Position Clutch — Clutch engages in any one of three positions. This has a maximum revolution of 120° before engaging.

4. <u>4 Position Clutch</u> Clutch engages in any one of four positions. This has a maximum revolution of 90° before engaging.

The time delay created by the clutch lag was calculated by dividing the machine stroke time by 2 (as in the case of a 2 Position Clutch), 3 and 4. The following times are the results of this calculation. Again, all times are shown in TMU (Time Measurement Units).

Strokes/min	Stroke time in T.M.U.	2 Position clutch	3 Position clutch	4 Position clutch
50	33.3	16.7	11.1	8.3
60	27.8	13.9	9.3	7.0
70	23.8	11.9	7.9	6.0
80	20.8	10.4	6.9	5.2
90	18.5	9.3	6.2	4.6
100	16.7	8.4	5.6	4.2
110	15.3	7.7	5.1	3.8
120	13.9	7.0	4.6	3.5
130	12.8	6.4	4.3	3.2
140	11.9	6.0	4.0	3.0
150	11.1	5.6	3.7	2.8

STEP #3 - <u>Distance of Reach for Corresponding Time, under Various Stroke Lengths and Speeds with Variable Clutches</u>

The third step is to convert the times, found in steps one and two, into distance. As this is done through the use of MTM, a more detailed explanation of the basic motion reach is warranted.

Reach can be defined as being the basic motion employed when the predominate purpose is to move the hand to a destination or general location. There are three variables which affect reach.

1. Distance reached in inches.
2. Condition, or nature of object, toward which the reach is made.
3. The continuity of motion - whether or not the hand is in motion at the beginning and/or the end of the reach.

<u>Distance reached</u> is a variable that is apparent and self explanatory, for it can be readily seen that to reach 20 inches would consume more time than to reach 2 inches under the same conditions.

<u>Condition of Motion</u> has been broken down into five cases:

Case A - When reaching to an object in a fixed location, or to an object in the other hand, or on which the other hand rests.

Case B - When reaching to a single object in a location which may vary slightly from cycle to cycle.

Case C - When reaching to an object jumbled with other objects in a group, so that search and select occur.

Case D - When reaching to a very small object, or where an accurate grasp is required.

Case E - When reaching to an indefinite location to get hand in position for body balance, or for the next motion or out of the way.

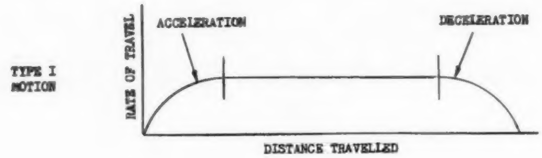
<u>Continuity of Motion</u> has been broken down into three types:

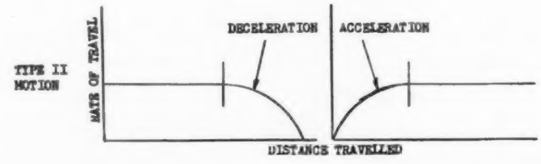
Type I - When the hand is not moving at the beginning or end of the reach.

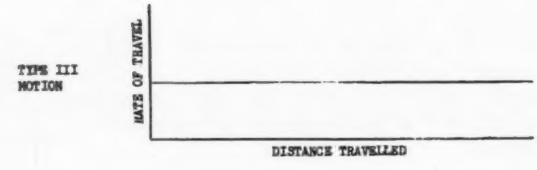
Type II - When the hand is in motion at either the beginning or end of the reach.

Type III - When the hand is in motion at both the beginning and end of the reach.

These can be best illustrated by the following diagrams:







APPLICATION I

The reach an operator would use when reaching into the die from the trip would likely be made to a slug, piece, or to the die or punch. In all these cases, the reach would be to a single object whose location may vary slightly. This is a Case B reach. The type of motion would be Type I, where both acceleration and deceleration would be required. Distance reached is the other variable, which in this case is unknown, but we do know the time required. Hence, it is possible to find the distance from the data card by fitting the time, type of motion, and case of reach, into the table.

Up to this point there has been no consideration given to the use of an allowance for a safety factor. To arrive at a conclusion all possible contributing phases must be reviewed.

1. It is a recognized fact that the average operator cannot increase efficiency by any more than approximately 20% in speed of movement alone.

2. The greater the distance, the greater the possibility of body movements to assist in accomplishing a reach.

3. Some of the dual trips on an air clutch have a minor delay between tripping of the press and clutch engagement. This is probably caused by the pressure building up in the line to a sufficient strength to actuate the clutch.

After careful consideration, it was decided, that by doubling the distance an operator could reach at the average performance level (data card distance - time relation) would allow a sufficient safety factor.

The possibility of combined motions in the greater distances, resulted in the limiting of the reach distance to 36", and recommending that if any reach in excess of 36" is required for the desired safety, the pedestal type trip should be used, or other safety devices incorporated.

In converting the time values already calculated to distance, it was found necessary to interpolate the reach table as shown on the data card. This was done for Reach, Class B, Type I motion, and for Reach, Class B, Type III motion, noted as R-B and m R-B m respectively.

The reason for both types being shown is to enable the compilation of a simple table for application. The actual reach performed by an operator in all cases would be an R-B reach.

As the final tables vary with length of stroke, strokes per minute, and the additional factor of clutch lag when required, the basis for table I has been calculated on a R-B motion, with the added clutch lag, table 2, as an m R-B m motion. The acceleration and deceleration having been allowed for in table I.

Distance	R-B Time in TMU's	m R-B m Time in TMU's	Distance	R-B Time in TMU's	m R-B m Time in TMU's
5	7.8	2.2	21	19.4	13.8
6	8.6	2.8	22	20.1	14.5
7	9.3	3.7	23	20.8	15.4
8	10.1	4.3	24	21.5	16.1
9	10.8	5.0	25	22.2	16.8
10	11.5	5.7	26	22.9	17.5
11	12.2	6.4	27	23.7	18.3
12	12.9	7.3	28	24.4	19.0
13	13.7	7.9	29	25.1	19.9
14	14.4	8.6	30	25.8	20.6
15	15.1	9.3	31	26.5	21.3
16	15.8	10.0	32	27.2	22.0
17	16.5	10.9	33	28.0	22.8
18	17.2	11.6	34	28.7	23.5
19	17.9	12.3	35	29.4	24.2
20	18.6	13.0	36	30.1	24.9

The final table expression is a result of converting the time values found in step 2 into distance through the use of the foregoing reach interpolations and appears as outlined in the final result, which is the application sheet.

APPLICATION I

APPLICATION SHEET

GUIDE FOR SAFE LOCATION OF TWO-HAND TRIP BUTTONS ON POSITIVE TYPE CLUTCH, PUNCH PRESSES

The distance shown in the following tables have been calculated working from the nearest edge of the punch and die, but <u>should be applied to the closest point of danger</u>.

All distances shown have been calculated to allow 200% of the average performance level.

<u>NOTE</u>: Where the total distance shown is greater than 36" other safety devices should be used.

Case A Positive clutch <u>with no</u> clutch lag use table 1

Case B Positive clutch <u>with</u> clutch lag - use table 1 plus table 2

TABLE #1

STROKE LENGTH	Number of Strokes Per Min.										
	50	60	70	80	90	100	110	120	130	140	150
2"	27	22	18	15	12	11	9	8	7	6	5
3"	30	24	20	16	14	12	10	9	8	7	6
4"	31	25	21	17	15	13	11	10	8	7	7
5"	32	26	21	18	15	13	12	10	8	8	7
6"	33	27	22	18	16	14	12	10	9	8	7
7"	34	27	22	19	16	14	12	11	9	8	7
8"	34	27	22	19	16	14	12	11	10	8	7
9"	34	28	23	19	17	14	13	11	10	8	8
10"	35	28	23	19	17	15	13	11	10	9	8
11"	35	28	23	20	17	15	13	11	10	9	8
12"	35	28	24	20	17	15	13	11	10	9	8
13"	36	29	24	20	17	15	13	12	10	9	8
14"	36	29	24	20	17	15	13	12	10	9	8
15"	36	29	24	20	17	15	13	12	10	9	8

TABLE #2

No. of Positions	Max Rotation	Number of Strokes Per Min.										
		50	60	70	80	90	100	110	120	130	140	150
2	180°	-	-	34	30	27	25	23	21	20	19	17
3	120°	32	27	24	21	19	17	16	15	14	13	12
4	90°	25	21	19	16	15	14	13	12	11	10	10

APPLICATION II

With the emphasis that exists on Material Handling in Industry today, the "Journal" presents an interesting Time Formula of Banding Pallett Loads.

OPERATING TIME FORMULA REPORT

by

O. D. Scarborough
U. S. Naval Ammunition Depot
Crane, Indiana

Formula No. 1
Date: 4/19/57

PART:

Band with steel strapping wood or steel containers to a 40" x 48" steel or wood pallet.

OPERATION:

Band pallet of containers.

MATERIAL:

Steel banding 1/2" to 3/4" wide.

WORK STATION:

Any packing or shipping area.

ALLOWED TIME:

a. Loads 10 inches to 45 inches in height
   .00210 + X(.01361 + Table I)
   Where X = number of bands per pallet load.

b. Loads 45 inches to 65 inches in height
   .00210 + X(.01448 + Table I)
   Where X = number of bands per pallet load.

APPLICATION:

This formula applies to the banding of containers with two to eight 1/2" to 3/4" steel bands with one metal seal per band, by the method in use at the present time. The length of banding, from 120" to 210" in length, varies with the height of the load on the pallet. The bands will run through the pallet parallel to the pallet stringers.

ANALYSIS:

This operation is manual. It is performed by one operator. The operator will band pallets in other areas or may perform other work such as load pallets, package material or stencil boxes when not fully occupied by banding operations. The other operations are not covered by this formula.

Tools used consist of one hand operated banding stretcher, one seal crimper, one signode model DF-10 banding dispenser mounted on wheels and fitted with a spool of 1/2" or 3/4" banding. The size of the pallet is 40" x 48" and is made of either steel or wood. The pallet rests on the floor always in the same general area. The bands must always encircle the load passing through the pallet. Two to eight bands are used per pallet. All bands are parallel to one another and to the pallet stringers.

The operator will be furnished written operator instruction and sketch showing the number of bands, size and location of banding on pallet.

A 15% allowance is included in the allowed time.

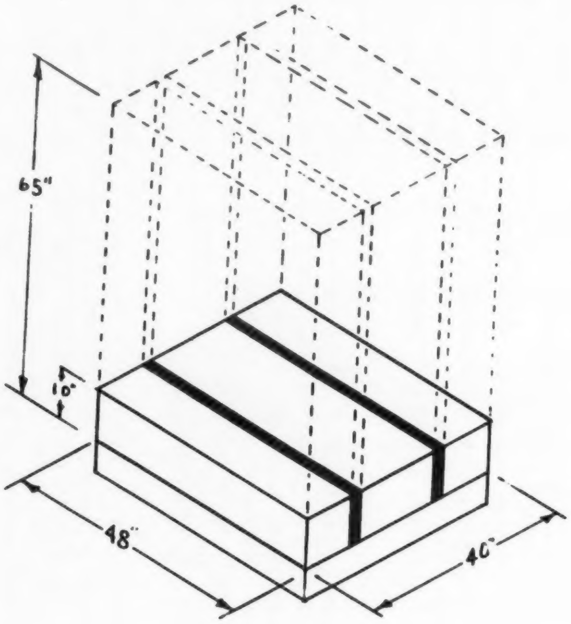
PROCEDURE:

As soon as the pallet is loaded the operator reaches for the steel banding and grasps it and shoves it through the pallet. When the correct amount of banding has been threaded through the pallet the operator walks to the opposite side of the pallet. He stoops and grasps the banding with right or left hand (owing to the side of the pallet being banded) and returns to the opposite side of pallet with the end of banding, laying the band on top of load. He then grasps the loop end of the banding at the banding dispenser and moves the loop to join the cut end of banding. The operator gets the band stretcher and positions it on the banding. He takes up the slack by operating the stretcher. Next he places a seal on the banding and completes tightening the strap. He gets the crimper and crimps the seal. Then he removes the stretcher and breaks the banding by bending it back and forth at the seal. He then returns stretcher and crimper to the top of the load or to band dispenser.

TABLE I

THREAD BAND THROUGH PALLET FROM HEIGHT 10" to 66"

No. of Bands	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66
1	.0188	.0189	.0190	.0190	.0191	.0191	.0192	.0192	.0193	.0193	.0193	.0194	.0194	.0195	.0195	.0195	.0196	.0196	.0205	.0206	.0206	.0206	.0207	.0207	.0207	.0208	.0208	.0208	.0209
2	.0356	.0357	.0358	.0359	.0360	.0361	.0362	.0364	.0365	.0365	.0366	.0367	.0367	.0368	.0369	.0370	.0371	.0371	.0390	.0390	.0391	.0392	.0392	.0393	.0394	.0394	.0395	.0395	.0396
3	.0523	.0525	.0527	.0528	.0530	.0532	.0533	.0534	.0535	.0536	.0538	.0539	.0540	.0542	.0543	.0544	.0545	.0547	.0574	.0575	.0576	.0577	.0578	.0579	.0580	.0581	.0582	.0583	.0584
4	.0690	.0693	.0695	.0697	.0700	.0702	.0703	.0705	.0707	.0708	.0710	.0711	.0713	.0715	.0717	.0719	.0720	.0722	.0758	.0760	.0761	.0763	.0764	.0765	.0766	.0767	.0769	.0770	.0771
5	.0858	.0861	.0864	.0867	.0870	.0872	.0874	.0876	.0878	.0880	.0882	.0884	.0887	.0889	.0891	.0893	.0895	.0897	.0943	.0945	.0947	.0948	.0950	.0951	.0953	.0954	.0956	.0957	.0959
6	.1024	.1028	.1032	.1036	.1039	.1042	.1045	.1047	.1049	.1052	.1054	.1057	.1060	.1062	.1065	.1067	.1070	.1072	.1127	.1129	.1132	.1133	.1135	.1137	.1139	.1141	.1142	.1144	.1146
7	.1192	.1196	.1201	.1206	.1209	.1212	.1215	.1218	.1221	.1224	.1226	.1229	.1233	.1236	.1239	.1242	.1245	.1247	.1311	.1314	.1317	.1319	.1321	.1323	.1325	.1327	.1329	.1331	.1333
8	.1359	.1364	.1369	.1374	.1379	.1383	.1386	.1389	.1392	.1395	.1399	.1402	.1406	.1409	.1413	.1416	.1419	.1423	.1495	.1499	.1502	.1504	.1507	.1509	.1511	.1514	.1516	.1519	.1521



PALLET

STRETCHER SEALER

STRAP DISPENSER

BANDING OPERATION

APPLICATION II

TABLE OF ELEMENTS

		TMUs	Conversion factor .00001 leveled time	Allowance	Allowed Time
A	Stretcher, crimper, get and place on load	51.6	.000516	15%	.00059
B	Seals, get several and place on load	92.3	.000923	15%	.00106
C	Thread banding through pallet				
	a. 10" High Table I	270.9	.002709	15%	.00312
	b. 20" High Table I	296.6	.002966	15%	.00341
	c. 30" High Table I	313.7	.003137	15%	.00361
	d. 40" High Table I	333.0	.00333	15%	.00383
	e. 50" High Table I	350.7	.003507	15%	.00403
D	Walk to opposite end of pallet	92.5	.000925	15%	.00106
E	Return to original end of pallet with band	91.9	.000919	15%	.00106
F	Band and loop together	79.7	.000797	15%	.00092
G	Stretcher, get, place under band (load height under 45")	84.8	.000848	15%	.00098
H	Stretcher, get, place under band (load height over 45")	107.4	.001074	15%	.00124
J	Tighten banding to remove slack and add seal (load height under 45")	149.0	.00149	15%	.00171
L	Tighten banding to remove slack get seal and add to band (load height 45" and over)	202.0	.00202	15%	.00232
M	Band, complete tightening	57.1	.000571	15%	.00066
N	Crimper, get crimper and crimp seal	117.1	.001171	15%	.00135
P	Crimper, remove and aside	31.5	.000315	15%	.00036
Q	Stretcher, band, remove	81.2	.000812	15%	.00093
R	Banding, break, bend end and aside	120.8	.001208	15%	.00139
T	Banding dispenser, relocate	228.8	.002288	15%	.00263
U	Walk, to pallet for next band	48.6	.000486	15%	.00056
V	Remove crimper and band stretcher to band dispenser	38.7	.000387	15%	.00045

OPERATION SUMMARY

PART Loaded Pallet DATE 19 Apr 1 STUDY No.

OPERATION Band Pallet ANALYST ODS SHEET No. 8 OF 24 SHEETS

No.	ELEMENT DESCRIPTION	ANALYSIS CHART REF.	ELEMENT TIME TMU	CONVERSION FACTOR LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
A	Band stretcher and crimper, get and place on load		51.6	.000516	15%	.00059	1	.00059
B	Seals, get several seals and place on load		92.3	.000923	15%	.00106	1	.00106
Ca.	Thread banding through pallet (10" high)		270.9	.002709	15%	.003115	1	.00312
Cb.	Thread banding through pallet (20" high)		296.6	.002966	15%	.00341	1	.00341
Cc.	Thread banding through pallet (30" high)		313.7	.003137	15%	.003607	1	.00361
Cd.	Thread banding through pallet (40" high)		333.0	.00333	15%	.003829	1	.00383
Ce.	Thread banding through pallet (50" high)		350.7	.003507	15%	.004033	1	.00403
D	Walk to opposite end of pallet and get band		92.5	.000925	15%	.00106	1	.00106
E	Return to original end of pallet w/band		91.9	.000919	15%	.00106	1	.00106
F	End of band and loop together		79.7	.000797	15%	.00092	1	.00092
G	Stretcher,band, get and place under band (Load height under 45")		84.8	.000848	15%	.00098	1	.00098
H	Stretcher, band,get and place under band (Load height 45" & over)		107.4	.001074	15%	.00124	1	.00124
J	Tighten banding to remove slack and add seal (Load height under 45")		149.0	.00149	15%	.00171	1	.00171
L	Tighten banding to remove slack and get and add seal (Load height 45" and over)		202.0	.00202	15%	.00232	1	.00232
M	Band, complete tightening		57.1	.000571	15%	.00066	1	.00066
N	Get crimper and crim;p seal on band		117.1	.001171	15%	.00135	1	.00135
P	Crimper remove and aside		31.5	.000315	15%	.00036	1	.00036
Q	Remove band stretcher		81.2	.000812	15%	.00093	1	.00093
R	Banding break, bend end and aside		120.8	.001208	15%	.00139	1	.00139
T	Banding dispenser relocate for next band		228.8	.002288	15%	.00263	1	.00263
U.	Walk to pallet for next banding		48.6	.000486	15%	.00056	1	.00056

METHODS ENGINEERING COUNCIL FORM NO. 199

TOTAL TIME ALLOWED PER

OPERATION SUMMARY

PART Loaded Pallet DATE 19 Apr -.57 STUDY No.

OPERATION Band Pallet ANALYST ODS SHEET No. 9 OF 24 SHEETS

No.	ELEMENT DESCRIPTION	ANALYSIS CHART REF.	ELEMENT TIME TMU	CONVERSION FACTOR LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
V.	Remove crimper and band stretcher to band dispenser after last banding		38.7	.000387	15%	.00045	1	.00045

METHODS ENGINEERING COUNCIL FORM NO. 199

TOTAL TIME ALLOWED PER

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. ______ — STUDY No. ______

OPERATION Band Pallet — ANALYST ODS — SHEET No. 10 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
A Band stretcher and crimper,						
get and place on load						
			18.6	TBC1		Turn to stretcher and crimper
Reach to crimper		R20B		~~R20B~~		Reach to crimper
Grasp crimper		G1A	2.0	G1A		Grasp
			29.0	B		Bend
				~~TBC1~~		Turn body
Move crimper to load		M16B		~~M16B6~~		Move stretcher to load
			2.0	RL1		Release stretcher
			51.6			
B Seals, get several seals and						
place on load						
			21.2	R22C		Reach to seals
				~~TBC1~~		
			9.1	G4B		Grasp seal
			11.2	G2	2	Regrasp seal
			9.1	G4B		Grasp second seal
			11.2	G2	2	Regrasp seal
			9.1	G4B		Grasp other seal
			19.4	M22B		Move seal to load
				~~TBC1~~		Turn body
			2.0	RL1		Release
			92.3			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
A	Band stretcher and crimper, get and place on load	51.6	.000516	15%	.00059	1	.00059
B	Seals, get several seals and place	92.3	.000923	15%	.00106	1	.00106
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 100

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. ______ — STUDY No. ______

OPERATION Band Pallet — ANALYST ODS — SHEET No. 11 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
C-a. Thread banding through pallet (10" high)						
			29.0	S		To banding
Reach to banding		R28B		~~R28B~~		Reach to banding
Grasp banding		G1A	2.0	G1A		Grasp banding
Move end of banding to		M8B	92.4	M28B	4	Move banding through pallet
pallet						
Release banding		RL1	8.0	RL1	4	Release banding
			97.6	R28B	4	Reach to banding
Guide banding w/LH			8.0	G1A	4	Grasp banding
			2.0	RL1		Release banding
			31.9	AS		Arise
				~~W1P~~		Walk
			270.9			
C-b. Thread banding through pallet (20" high)						
			29.0	S		To banding
Reach to banding		R28B		~~R28B~~		Reach to banding
Grasp banding		G1A	2.0	G1A		Grasp banding
Move end of banding to pallet		M8B	92.4	M28B	4	Move banding through pallet
Release banding		RL1	8.0	RL1	4	Release banding
			97.6	R28B	4	Reach to banding
			8.0	G1A	4	Grasp banding
Guide banding w/LH			11.5	R10B		Reach to banding
			2.0	G1A		Grasp banding
			12.2	M10B		Move banding
			2.0	RL1		Release banding
			31.9	AS		Arise
				~~W1P~~		Walk
			296.6			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
C-a.	Thread banding through pallet (10" high)	270.9	.002709	15%	.003115	1	.00312
C-b.	Thread banding through pallet (20" high)	296.6	.002966	15%	.00341	1	.00341
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 100

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. ____ — STUDY No. ____

OPERATION Band Pallet — ANALYST ODS — SHEET No. 12 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
C-c. Thread banding through pallet (30" high)						
			29.0	S		To banding
Reach to banding		R28B		~~R28B~~		Reach to banding
Grasp banding		G1A	2.0	G1A		Grasp banding
Move end of banding to pallet		M8B	92.4	M28B	4	Move banding through pallet
Release banding		RL1	10.0	RL1	4	Release banding
			97.6	R28B	4	Reach to banding
			10.0	G1A	4	Grasp banding
Guide banding w/LH			18.6	R20B		Reach to banding
			2.0	G1A		Grasp banding
			18.2	M20B		Move banding through pallet
			2.0	RL1		Release banding
			31.9	AS		Arise
				~~W1P~~		Walk
			313.7			
C-d. Thread banding through pallet (40" high)						
			29.0	S		To banding
Reach to banding		R28B		~~R28B~~		Reach to banding
Grasp banding		G1A	2.0	G1A		Grasp banding
Move end of banding to pallet		M8B	115.5	M28B	5	Move banding through pallet
Release banding		RL1	10.0	RL1	5	Release banding
			122.0	R28B	5	Reach to banding
Guide banding w/LH			10.0	G1A	5	Grasp banding
			4.0	R2B		Reach to banding
			2.0	G1A		Grasp banding
			4.6	M2B		Move banding through pallet
			2.0	RL1		Release banding
			31.9	AS		Arise
				~~W1P~~		Walk
			333.0			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
C-c.	Thread banding through pallet (30" high)	313.7	.003137	15%	.003607	1	.00361
C-d.	Thread banding through pallet (40" high)	333.0	.00333	15%	.003829	1	.00383
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 198

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. ____ — STUDY No. ____

OPERATION Band Pallet — ANALYST ODS — SHEET No. 13 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
C-e. Thread banding through pallet (50" high)						
			29.0	S		To banding
Reach to banding		R28B		~~R28B~~		Reach to banding
Grasp banding		G1A	2.0	G1A		Grasp banding
Move end of banding to pallet		M8B	115.5	M28B	5	Move banding through pallet
		RL1	10.0	RL1	5	Release banding
			122.0	R28B	5	Reach to banding
Guide banding w/LH			10.0	G1A	5	Grasp banding
			12.9	R12B		Reach to banding
			2.0	G1A		Grasp banding
			13.4	M12B		Move banding through pallet
			2.0	RL1		Release banding
			31.9	AS		Arise
				~~W1P~~		Walk
			350.7			
D. Walk to opposite end of pallet and get band						
			60.0	W4P		Walk to edge of pallet
			29.0	S		Toward banding
				~~TBC1~~		Turn body
				~~R20B~~		Reach to banding
			3.5	G1B		Grasp banding
			92.5			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
C-e.	Thread banding through pallet (50" high)	350.7	.003507	15%	.004033	1	.00403
D	Walk to opposite end of pallet and get band	92.5	.000925	15%	.00106	1	.00106
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 198

ETHODS ANALYSIS CHART

PART Loaded Pallet DATE 19 Apr 1957 REFERENCE No. ____ STUDY No. ____

OPERATION Band Pallet ANALYST ODS SHEET No. 14 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
E. Return to original end of pallet w/band						
			31.9	AS		Arise, bend w/banding
				~~TBC1~~		From pallet
			60.0	W4P		Walk to band reel
				~~G2~~		Regrasp
			91.9			
F. End of band and loop together						
			29.0	B		Bend to band
Reach to loop		R20B		~~TBC1~~		To pallet
Grasp band		G1A	2.0			
Move band to load		M24C	31.9	AB		Aside and side step w/loop of band
Regrasp band		~~G2~~		~~SS12C1~~		
Release band		RL1	16.8	G2	3	Regrasp and align in band
			79.7			
G. Stretcher, band, get and place under band						
(Load height under 45")						
Reach to band stretcher		R16B	15.8			
Grasp stretcher		G1A	2.0			
Move stretcher to band		M14B6	17.7			
Squeeze device		AP1	16.2			
Move to band		M2C6	5.8			
Position stretcher		P2SSD	25.3			
Release stretcher		RL1	2.0			
			84.8			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
E.	Return to original end of pallet w/band	91.9	.000919	15%	.00106	1	.00106
F.	End of band and loop together	79.7	.000797	15%	.00092	1	.00092
G.	Stretcher, band, get and place under band (Load height under 45")	84.8	.000848	15%	.00098	1	.00098
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 196

ETHODS ANALYSIS CHART

PART Loaded Pallet DATE 19 Apr 1957 REFERENCE No. ____ STUDY No. ____

OPERATION Band Pallet ANALYST ODS SHEET No. 15 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
H. Stretcher, band, get and place under band						
(Load height 45" and over)						
			25.8	R30B		Reach to stretcher
			2.0	G1A		Grasp stretcher
			28.0	M30B6		Move stretcher to band
			16.2	AP1		Squeeze device
			8.1	M2C6		Move to band
			25.3	P2SSD		Position stretcher
			2.0	RL1		Release
			107.4			
J. Tighten banding to remove slack and						
add seal (Load height under 45")						
Reach to handle		R8A	11.5	R10B		Reach to seal grasp seal
Grasp handle		G1A	2.0	G1A		Grasp seal
Handle up	5	M8B	53.0	M10B		Move seal to band
Handle down	5	M8A	48.5	G2		Regrasp seal
			6.7	M3C		Move seal on band
			25.3	P2SSD		Position seal over banding
			2.0	RL1		Release seal
			149.0			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
H	Stretcher, band, get & place under band (Load height 45" and over)	107.4	.001074	15%	.00124	1	.00124
J	Tighten banding to remove slack and add seal (Load height under 45")	149.0	.00149	15%	.00171	1	.00171
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 196

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. — STUDY No.
OPERATION Band Pallet — ANALYST ODS — SHEET No. 16 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
L. Tighten banding to remove slack and get and add seal						
(Load height 45" and over)						
Reach to handle		R8A	26.7	R30C		Reach to seal on tray
Grasp handle		G1A	9.1	G4B		Grasp seal
			30.7	M30B		Seal to banding
				~~G2~~		Regrasp seal
Handle up	5	M8B5	53.0			
Handle down	5	M8A5	48.5			
			6.7	M3C		Seal on banding
			25.3	P2SSD		Position seal on banding
			2.0	RL1		Release seal
			202.0			
M. Band, complete tightening						
Handle down		M8A5	12.5			
Handle up		M8B	10.6			
Handle down		M8A5	15.8	R16B		Reach to crimper
		AP1	16.2			
		RL1	2.0	G1A		Grasp crimper
			57.1			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
L	Tighten banding to remove slack and get and add seal (Load height 45" and over)	202.0	.00202	15%	.00232	1	.00232
M	Band, complete tightening	57.1	.000571	15%	.00066	1	.00066
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 190

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. — STUDY No.
OPERATION Band Pallet — ANALYST ODS — SHEET No. 17 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
N. Get crimper and crimp seal on band						
Reach to crimper		R18B	17.2	M6B		Move crimper toward band
Grasp crimper		G1A	2.0			
Crimper toward banding		M14C	22.1	M20C		Crimp to band
Regrasp crimper		G2	5.6	G2		Regrasp
Position crimper on sealer		P2SSD	25.3	P2SSD		Position crimper on sealer
Take up slack		M3A	4.9	M3A		Take up slack
Regrasp crimper		G2	5.6	G2		Regrasp crimper
Close crimper		M7A20	18.2	M7A20		Close crimper
Squeeze to close		AP1	16.2	AP1		Squeeze to close
			117.1			
P. Crimper remove and aside						
Open crimper		M10A	11.3	M10A		Open crimper
Aside crimper		M16B	18.2	M20B		Aside crimper
Release crimper		RL1	2.0	RL1		Release crimper
			31.5			
Q. Remove band stretcher						
Reach to band stretcher		R8B	15.8	R16B		Reach to band
Grasp band stretcher		G1A	2.0	G1A		Grasp band
Thumb on latch		G5	.0			
Move latch		M1A	2.5			
Regrasp		G2	5.6			
Squeeze device		AP1	16.2			
Remove stretcher from band		D3E	22.9			
			16.2	AP1		Bend banding
			81.2			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
N	Get crimper and crimp seal on band	117.1	.001171	15%	.00135	1	.00135
P	Crimper remove and aside	31.5	.000315	15%	.00036	1	.00036
Q	Remove band stretcher	81.2	.000812	15%	.00093	1	.00093
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 190

ETHODS ANALYSIS CHART

PART Loaded Pallet — DATE 19 Apr 1957 — REFERENCE No. — STUDY No.

OPERATION Band Pallet — ANALYST ODS — SHEET No. 18 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
R. Banding break, bend end and aside						
Aside band stretcher		M12B5	10.6	AP2		To bend banding
Release band stretcher		RL1	8.7	M4A5		Bend banding
Aside band		R-E	36.6	M4A	6	Bend band and fold to break
			16.8	G2	3	Regrasp band
			16.2	AP1		Bend band w/fingers
			31.9	AB		Aside
			120.8			
T. Banding dispenser relocate for next band						
			18.6	TBC1		Toward dispenser
			60.0	W4P		Walk to dispenser
			37.2	TBC2		Get in position
				~~R12B~~		Reach to grab handle
To base of dispenser		LM12	14.3	~~G1A~~		Grasp handle
Tilt dispenser back		M8B10	15.7	M8B10		Tilt dispenser back
Return leg to position		LM12	14.3			
			51.0	W3PO		Walk backward
Cart to normal position		M8B10	15.7	M8B10		
Release		RL1	2.0	RL1		Release
			228.8			
U. Walk to pallet for next banding						
			18.6	TBC1		Toward banding
			30.0	W2P		Walk between pallet and dispenser
			48.6			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
R	Banding break, bend end and aside	120.8	.001208	15%	.00139	1	.00139
T	Banding dispenser relocate for next band	228.8	.002288	15%	.00263	1	.00263
U	Walk to pallet for next banding	48.6	.000486	15%	.00056	1	.00056
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 198

METHODS ANALYSIS CHART

PART Loaded Pallet — DATE — REFERENCE No. — STUDY No.

OPERATION Band Pallet — ANALYST ODS — SHEET No. 19 OF 24 SHEETS

DESCRIPTION — LEFT HAND	No.	L H	TMU	R H	No.	DESCRIPTION — RIGHT HAND
V. Remove crimper and band stretcher to band dispenser after last banding						
			12.9	R12B		Reach to crimper
			2.0	G1A		Grasp
Move stretcher to dispenser tray		M20B6	21.8	TBC1		Turn to dispenser
				~~M20B~~		Move to dispenser tray
		RL1	2.0	RL1		Release
			38.7			

No.	ELEMENT DESCRIPTION	ELEMENT TIME TMU	CONVERSION FACTOR .00001 LEVELED TIME	% ALLOWANCE	ELEMENT TIME ALLOWED	OCCURRENCES PER PIECE OR CYCLE	TOTAL TIME ALLOWED
V	Remove crimper and band stretcher to band dispenser after last banding	38.7	.000387	15%	.00045	1	.00045
						TOTAL	

METHODS ENGINEERING COUNCIL FORM NO. 198

ELEMENT ANALYSIS

Element Description	Classification	Influencing Factor
A Stretcher, crimper, get and place on load	Constant	Stretcher and crimper will always be in same location (load up to 45" high)
B Seals, get several and place on load	Constant	Motion pattern will vary somewhat but an average motion pattern has been used. Generally four seals will be obtained as an average. However, three grasps have been allowed because two seals will interlock slightly and both can be grasped simultaneously.
C Thread banding through pallet		(The length of band will vary (with height of load.
a. 10" High (Table I)	Variable	
b. 20" High (Table I)	Variable	
c. 30" High (Table I)	Variable	
d. 40" High (Table I)	Variable	
e. 50" High (Table I)	Variable	
D Walk to opposite end of pallet	Constant	Pallet will always be 40" x 48" Slight variation in walking distance but average is used.
E Return to original end of pallet with band	Constant	Same as El. D
F Place end of band and loop together	Constant	When load is over 15" high the motion pattern is always the same. When load is less than 15" then an arise from bend does not occur but a 24" move is limiting. The difference in total time for the two elements would be less than four TMUs. The element has been called a Constant and the higher time value has been used.
G Stretcher, get and place under band (load 10" to 45" high)	Constant	Motion pattern is constant.
H Stretcher, get and place under band (load 45" to 65" high)	Constant	Motion pattern is constant.
J Tighten banding, remove slack and add seal.	Constant	Average motion pattern has been used.

ELEMENT ANALYSIS (Cont'd)

Element Description	Classification	Influencing Factor
L Seal, get and add to band	Constant	Motion pattern does not vary.
M Band complete tightening	Constant	Same as El. above
N Crimper, get crimp and crimp seal	Constant	Same as El. above
P Crimper, remove and aside	Constant	Same as El. above
Q Stretcher band, remove	Constant	Same as El. above
R Banding, break, bend end and aside	Constant	Same as El. above
T Banding dispenser relocate	Constant	Pallet will always be 40" wide and the number of steps is the only variable. An average number of steps has been used.
U Walk, to pallet for next band	Constant	An average motion pattern has been used.
V Crimper, band stretcher, remove and aside after last banding	Constant	Motion pattern does not vary.

SYNTHESIS

CONSTANT PER BAND (Load up to 45" high)

K1 = D + E + F + G + J + M + N + P + Q + R + T - U

.00106 + .00106 + .00092 + .00098 + .00171 + .00066 + .00135 + .00036 + .00093 + .00139 + .00263 + .00056 = .01361

CONSTANT PER BAND (Load 45" to 65" high)

K2 = D + E + F + H + L + M + N + P + Q + R + T + U =

.00106 + .00106 + .00092 + .00124 + .00232 + .00066 + .00135 + .00036 + .00093 + .00139 + .00263 + .00056 = .01448

CONSTANT PER PALLET (Load under 45" high)

K3 = A + B + V

.00059 + .00106 + .00045 = .00210

ELEMENT C IS A VARIABLE. The motion pattern of pushing the band through the pallet will vary with the length of the band required to encircle the pallet. The length of the band required is determined by the perimeter (vertical) of the load. Since the width of the pallet (and the load) may be considered constant, the perimeter will vary only with the height of the load. Therefore the motion pattern of this element and the time varies directly with the height of the load.

The relationship of time and the height of the load is shown on Table I. The five MTM studies for element C have been plotted on the graph as shown on Table I using the Height of the Load as the abscissa or independent variable and Time in Hours as the ordinate for dependent variable.

SYNTH
TIME REQUIRED TO BAND PALLET

Loads 10 inches to 45 inches in height

K3 + X(K1 + Table I)

.00210 + X(.01361 + Table I)

Where X = numer of bands per pallet

Loads 45 inches to 65 inches in height

K3 + X(K2 + Table I)

.00210 + X(.01448 + Table I)

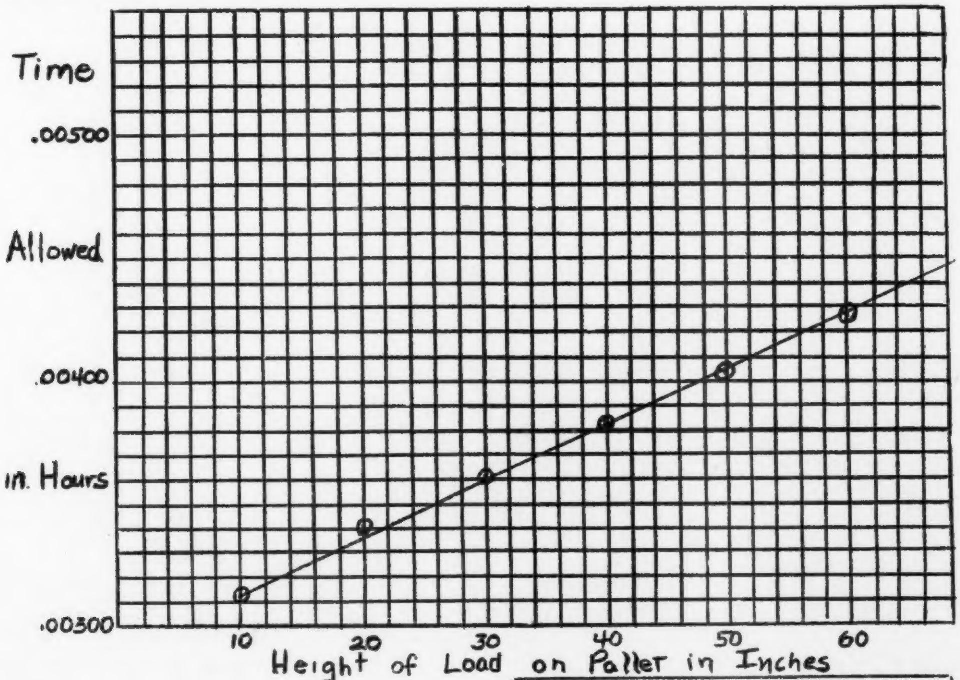
Where X = number of bands per pallet

INSPECTION

Banding must be taut and must not give more than 1 1/2" under a 25 pound pull. Crimped seal must be secure to prevent slippage of the band.

PAYMENT:

Day work.



Curve I - Thread Band Thru Pallet
O. D. Scarborough - NAD, Hawthorne - 4/14/57

Chapter News

The April meeting, MTM Association of Ohio, was held at the Hotel Alms, Cincinnati.

Major R. D. Struble, Air Materiel Command, Wright Patterson Air Force Base, presented a film on logistics problems faced and solved by the Air Force. He also discussed various management techniques employed to develop and maintain a high level of efficiency by the personnel of the Air Materiel Command, both military and civilian.

MTM Training

A new impact highlighted the second MTM course at Norton Air Force Base in San Bernardino, California. Among the 17 graduates were Mrs. Millie Rose and Mrs. Philomene Spisak, both management analysts in the Industrial Engineering Division of the Directorate of Supply and Services. Mrs. Rose and Mrs. Spisak are among the first Air Force Women to become registered MTM practitioners. Both placed in the upper half of the class in the examination scores.

The MTM courses at Norton are conducted by Mr. Norman F. Bohren, Chief, Production Control Branch in the Industrial Engineering Division of the Supply and Services Directorate. Mr. Bohren is one of the few licensed MTM instructors in the Air Force. With the new graduates, Norton Air Force Base now has 34 MTM certificate holders in the Industrial Engineering Divisions of the Supply and Maintenance Directorates.

Lt. Col. L. E. Heath, Deputy Director for Plans, Procedures and Quality, Directorate of Supply and Services, presented the coveted certificates at an Officers' Club luncheon in April 1958.

LADIES FIRST — Lt. Col. L. E. Heath presents certificates to Mrs. Philomene Spisak (left) and Mrs. Millie Rose, who are among the first Air Force women to become MTM practicioners. Mr. Norman Bohren instructed the MTM courses at Norton Air Force Base in San Bernardino, California. Seventeen graduates received certificates at the Officers' Club luncheon.

STANDING (from left):
George L. Hagner
Irven Hunter
A. T. Christensen
David E. Howard
Philomene C. Spisak
Norman Bohren (instructor)
Millie C. Rose
Early R. Hartley
Robert T. Smith
Trygve F. Dahle.

KNEELING:
James H. Kensinger
Charles W. Ashford
Donald R. Brown
Robert F. Bradley
Emerson Symonds
Lewis H. Winkle.

THE JOURNAL OF METHODS TIME MEASUREMENT

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RESEARCH REPORTS

R.R. 101 Disengage

This report contains a preliminary study of the element disengage. While it is still classified as tentative, the report contains some extremely interesting conclusions on the nature and theory of this element.

R.R. 102 Reading Operations

The first step in the use of MTM for establishing reading time standards is contained in this report. In addition, the report contains a synopsis of the work done in this field by 11 leading authorities.

R.R. 104 MTM Analysis of Performance Rating Systems

A talk presented at the SAM-ASME Time and Motion Study Conference, April 1952. It contains an analysis of performance rating systems and various performance Rating Films from an MTM standpoint.

R.R. 105 Simultaneous Motions

This report represents almost two man-year's work on a study of Simultaneous Motions. It is a final report of the Simultaneous Motions project undertaken by the MTM Association. While it does not purport to provide complete and exhaustive answers to all problems in the field of Simultaneous Motions, it presents a great deal of new and valuable information which should be of interest to every MTM practitioner.

R.R. 106 Short Reaches and Moves

This report contains an analysis of the characteristics of Reaches and Moves at very short distances. It develops important conclusions concerning the application of MTM to operations involving these short distance elements.

R.R. 107 A Research Methods Manual

The research activity of the Association has developed an effective and comprehensive set of methods for carrying on research in human motions. This report details the major techniques used. Adequate sources of motion data, film analysis, data recording, and statistical methods of analysis are among the topics discussed.

R.R. 108 A Study of Arm Movements Involving Weight

In this report, the results of a large investigation into the effect of weight on the performance times of arm movements are presented. While more effective means of determining correct time allowances for moving weights are given, the comprehensive discussion of the whole area of weight phenomena is probably of more fundamental importance. The effect of such conditions of performance as the use of one or two hands, sliding vs. spatial movements, and male and female performance are among the topics presented.

R.R. 109 A Study of Positioning Movements

I. The General Characteristics. II. Appendix.
This report, the first of two position reports, defines "positioning movements and the interrelation of component movements." The study is limited to the laboratory analysis, and contains an appendix dealing with several subjects outside the major objectives.

R.R. 110 A Study of Positioning Movements

III. Application to Industrial Work Measurement.
This report, the second on position, relates the results of the position research to the field of application. This study deals with actual industrial operators and work measurement tools, and the evolution of an improved and more efficient technique for controlling and improving manual activity through better understanding of positioning movements.

22.5	16.7	9.7	10.1	
23.9	18.0	10.5	11.5	
25.3	19.2	11.3	12.9	
26.7	20.4	12.1	14.4	
	21.7	12.9	15.8	
	22.9	13.7	17.3	
		14.5	18.8	
		15.3	20.2	
			21.7	
			23.2	

... single object in ... location which may vary slightly from cycle to cycle.

... other hand

C Reach to object jumbled with other objects in a group so that search and select occur.

D Reach to a very small object or where accurate grasp is required.

E Reach to indefinite location to get hand in position for body balance or next motion or out of way.

TABLE II—MOVE—M

Wt. (lb.) Up to	Wt. Allowance Factor	Wt. Allowance Constant TMU	CASE AND DESCRIPTION
2.5	0	0	A Move object to other hand or against stop.
...	1.06	2.2	
...11		3.9	B Move object to approximate or indefinite location.
		5.6	
...4			C Move object to exact location.

... AP

180°

...4

Case	Time TMU
1A	
1B	
1C1	
1C2	7...
1C3	8.7
2	10.8
3	
4A	5.6
4B	5.6
4C	7.3
	9.1
5	12.9
	0

Regr...

Trans...

Object ju... than 1" ...

Object jumbl... x 1/8" to 1" ...

Object jumbled ... than 1/4" x 1/4" ...

Contact, sliding or h...

TABLE V—P...

CLASS OF FIT		Sy...
1—Loose	No pressure required	SS
		NS
		S
2—Close	Light pressure required	SS
		NS
		S
3—Exact	Heavy pressure required.	SS
		NS

*Distance moved to engage—1" or less.

TABLE VI—RELEASE—RL

Case	Time TMU	DESCRIPTION
1	2.0	Normal release performed by opening fingers as independent motion.
2	0	Contact Release.

4...

47....

TABLE VII—DISEN...

CLASS OF FIT

1—Loose—... effort ... sub...

2—...

TABLE VIII—EYE...

Eye Trav...

Case

1A

B

7.

8.7

8

Regr

Transf

Object ju
than 1"

ct jumbl
" to 1"

umbled
" x ¼"

ding or h

V—P

Sy

SS

NS

S

SS

4

47.

DISEN